Energy in the deep subsurface and as extraterrestrial habitability analogs

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The deep subsurface is a group of environments that are relatively isolated from surface processes and far removed from phototrophic energy sources, characterized instead by oligotrophic and chemotrophic modes of life. They are therefore useful when considering the minimum energetic requirements for life and how communities fuel themselves in such resource limiting conditions, particularly as environmental conditions have a direct affect on the available energy of a redox reaction. Energy sources and limitation in the deep subsurface are also applicable when considering current primary targets for astrobiology investigations within the solar system such Mars, Enceladus, Europa and Titan have surface conditions that are largely considered inhospitable to life, but where subsurface conditions are potentially habitable. We will present new thermodynamic energetic calculations that suggest that some redox reactions on these extraterrestrial targets have comparable free energy yields of reactions and energy density to analog environments in Earth's deep subsurface. We will also present new findings from poised potential experiments that use electricity to mimic energetic potentials of iron and sulfur redox reactions to study microbial activity in the subsurface of oceanic crust.